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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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PILLSBURY WINTHROP, LLP P.O. BOX 10500 MCLEAN, VA 22102			EXAMINER MCDONALD, RODNEY GLENN	
			ART UNIT	PAPER NUMBER
			1753	

DATE MAILED: 08/09/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

<b>Office Action Summary</b>	Application No. 10/076,099	Applicant(s) JOHNSON ET AL.	
	Examiner Rodney G. McDonald	Art Unit 1753	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 19 May 2004.
- 2a) ☐ This action is **FINAL**.                      2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1-27 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-6 and 19-27 is/are rejected.
- 7) ☒ Claim(s) 7-18 is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All    b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- |  |   |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)  | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)                                   | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____  |

## DETAILED ACTION

### ***Claim Rejections - 35 USC § 102***

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this

Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1-5 and 19 are rejected under 35 U.S.C. 102(b) as being anticipated by Otsubo et al. (U.S. Pat. 4,808,258).

Otsubo et al. teach supplying a gas to produce a plasma for etching an aluminum film. (Column 3 lines 12-24) ***(Compare to Applicant's one process gas)*** The plasma processing method uses amplitude modulated high frequency voltage. ***(Compare to providing an RF electromagnetic field to the chamber)*** In this method, a gas pressure is made higher as compared with the conventional plasma processing method. Further, a high-frequency voltage  $V_2$  lower than the conventional voltage  $V_1$  (shown in FIG. 2) is applied between electrodes for a period  $t_1$ , as shown in FIG. 3. ***(Compare to providing the electromagnetic field at two values. This representing the first)*** Since the gas pressure is high, the ion energy at the period  $t_1$  is low, but the discharge current is increased at this period. Accordingly, the energy of an electron flowing from each electrode to a plasma is lowered, but the number of such electrons is increased. Thus, the production of a radical, which contributes to etching, is also increased. ***(Compare to performing a different treatment process)*** (Column 3 lines 47-61)

At a period  $t_2$ , a high-frequency voltage  $V_3$  higher than the conventional voltage  $V_1$  is applied between the electrodes, under a high gas pressure.

***(Compare to providing the electromagnetic field at two values. This representing a second value)*** Thus, ion energy necessary for removing the aluminum oxide film and for forming the side wall is obtained. ***(Compare to performing a different treatment process)*** The ion energy distribution in the above case is schematically shown in FIG. 4. (Column 3 lines 62-68)

The high frequency voltage is at 13.56 MHz. (Column 6 line 55)

***(Compare to providing an RF electromagnetic field to the chamber)***

The modulation can control the various waveforms such as rectangular and sinusoidal wave. (Column 6 lines 60-63) ***(Compare to providing a sinusoidal function)***

The voltage, amplitude and time period varies utilizing these values. (See Fig. 3 discussed above) ***(Compare to Applicant's required three values)***

The amount and energy of the ion can be changed by changing the ratio  $t_1/t_2$  and voltage  $V_3$ . ***(Compare to Applicant's required varying of the energy level during different repetition periods during respectively different time intervals.)***

In Fig. 8 a processing chamber is shown with a gas inlet 11 and gas outlet 12. (Column 6 lines 43-45) The gas outlet inherently requires a pump to maintain vacuum for plasma processing. This is also recognized in other embodiments, which require an evacuating means (not shown). (Column 8 line 68; Column 9 line 1) An RF power source is provided in the form of a standard

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signal generator 21 at a frequency of 13.56 MHz. (Column 6 lines 55-59) The signal generator produces an electromagnetic field which creates a plasma the field has an energy level that varies cyclically between at least two values as seen in Figure 3. The values are  $V_2$  and  $V_3$ . (See Fig. 3) (**Compare to Applicant's apparatus**)

**Claim Rejections - 35 USC § 103**

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claims 1 and 6 are rejected under 35 U.S.C. 103(a) as being unpatentable over Otsubo et al. (U.S. Pat. 4,808,258) in view of Heinecke et al. (U.S. Pat. 4,935,661).

Otsubo et al. is discussed above and all is as applies above. (See Otsubo et al. discussed above)

The differences not yet discussed are the control of the energy level and cyclically varying gas pressure.

Heinecke et al. '661 teach an apparatus for pulsed treatment of a substrate surface which includes means for removing spent gas from a region adjacent the substrate for each pulse. The apparatus may also include means for sweeping an intense plasma region across a substrate surface. Rapid gas exchange is provided by pressure pulsing the gas admission. This facility also provides means for rapidly alternating different gases. (See Abstract)

The arrangement shown in Fig. 4 provides a facility for changing the reactant gas from one gas to another with each plasma pulse (or succession of pulses). (Column 6 lines 18-22) To assist gas exchange a gas pulse facility may be provided by the arrangement of Fig. 4a. The amount of gas stored in the vessel 34 should be that which fills the reactor to the required operating pressure measured by the control 15, **which pressure may change from pulse to pulse**, and which is then maintained via the flow meter 30 during the remainder of the plasma pulse. Vessel 34 thus also acts as a buffer to prevent the mass flow controller trying to follow the pulsings. (Column 6 lines 42-55)

As well as film deposition the technique can also be used for etching. For example, using an electrode separation of 20 mm and argon gas at 140 mtorr **the bias voltage on the ground electrode was varied in the region 0 to -500 V DC to obtain an enhanced plasma which increased the etch rate of SiO**

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***whilst decreasing the resist degradation on a patterned Si wafer.*** (Column 11 lines 23-29)

The motivation for control of the energy level and cyclically varying the gas pressure is that it allows overcoming the disadvantages of the prior art. (Column 1 lines 3-55)

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have modified Otsubo et al. by controlling the energy and varying the gas pressure as taught by Heinecke et al. '661 because it allows for overcoming the disadvantages of the prior art.

Claims 19, 20, 21, 23, 24, 26 and 27 are rejected under 35 U.S.C. 103(a) as being unpatentable over in Otsubo et al. view of Mahawili (U.S. Pat. 4,993,358).

Otsubo et al. is discussed above and all is as applies above. (See Otsubo et al. discussed above)

The differences not yet discussed is the feeding of the gases through a manifold that has a plate with a plurality of nozzles and valves, each for supplying gas, and valve control means for controlling the nozzles intermittently.

Mahawili teach "vertical systems" including a susceptor for holding wafers in a chamber typically formed by an inverted bell jar. The susceptor is typically rotated for achieving greater uniformity in coatings across the surface of the wafers or substrate. (Column 1 lines 60-64)

It is further object of the invention to provide CVD reactor with a housing forming a closed chamber suitable for maintaining a wafer or deposition

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substrate in a controlled environment of selected pressure, etc. With the substrate supported in the chamber, and maintained at typical CVD temperatures, it is subjected to a deposition environment formed with means for introducing reactant gas into the chamber. (Column 2 lines 38-45)

More preferably, the means for introducing reactant gas into the chamber comprise multiple spaced apart orifices, sets of the orifices being in communication with external manifolds preferably of annular configuration. The arrangement of the external annular manifold permits the use of separate regulators in order to introduce one or more gases including reactant gases, carrier gases and the like as necessary for a particular deposition process being contemplated. The invention also contemplates possible use of a portion of the orifices as additional exhaust vents in order to make the CVD reactor or apparatus even more versatile. (Column 3 lines 6-18)

The CVD reactor comprises an upper or external **plate 28** forms ten radially spaced gas manifolds. (Column 4 lines 19-20) The inner plate 30 forms an array of gas inlets, **preferably sonic orifices generally indicated at 32A-50A**. (Column 4 lines 22-23) Each of the annular gas manifolds 32-50 is provided with **an external valve or regulator 32C-50C in an inlet conduit 32D-50D**. **The external regulators are adapted for connection with one or more sources of reactant gases such as those schematically indicated at 56 and 58**. Depending upon the specific application, different numbers of individual gas source could be employed. In any event, the two sources 56 and 58 indicate the possibility of combining two or more gases to form the reactant gas environment



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within the chamber 24. For example, in the deposition of silicon dioxide, the two sources 56 and 58 could provide silane and oxygen. However, as noted above, a wide variety of other gases could be employed as contemplated by the present invention. In any event, ***the gas sources 56 and 58 are selectively connected with one or more of the external regulators in order to assure optimum flow conditions for the reactant gas within the chamber 24.*** The sources 56 and 58 could be connected with the external regulators, for example, by conduits or the like (not shown). (Column 4 lines 45-65)

***At least one additional exhaust passage 66 is formed in an axially central portion of the chamber 24, preferably by the plates 28 and 30.*** The exhaust passage 66 is similarly in communication with an external exhaust member 68 having an individual control valve 70. The external exhaust members 62 and 68 may be connected for example with a vacuum pump as schematically indicated at 72, for example by conduit or the like (not shown). ***Additional exhaust passages (not shown) could be provided in the center of the chamber 24, if desired.*** (Column 5 lines 10-19)

The control valves 64 and 70 are adapted for sequential operation, preferably by ***automated means (not shown) in order to selectively open or close the individual exhaust passages 60 and 66 between the chamber 24 and vacuum means 72.*** (Column 5 lines 20-24)

The combination of control valves 64 and 70, either alone or in combination with the automated means referred to above, provides a kinetic means for regulating directionality of local flow vectors for reactant gas within the

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chamber 24 as described in greater detail below in a method of operation for the reactor 10. (Column 5 lines 25-30)

The motivation for providing for feeding of gases is that it allows for enhancing coating uniformity. (See Abstract)

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have utilized gas feeding means as taught by Mahawili because it allows for enhancing coating uniformity.

Claim 22 is rejected under 35 U.S.C. 103(a) as being unpatentable over Otsubo et al. in view of Mahawili as applied to claims 19, 20, 21, 23, 24, 26 and 27 above, and further in view of Bates et al. "Fast gas injection system for plasma physics", Rev. Sci. Instrum., Vol. 55, NO. 6, June 1984.

The difference not yet discussed is the use of a piezoelectric valve to regulate the gas flow.

Bates et al. teach a gas injection system that utilizes **a piezoelectric valve**. (See Bates et al. Abstract)

The motivation for utilizing a piezoelectric valve for a gas injection system is that it allows faster controlled injection. (See Abstract)

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have utilized a piezoelectric valve to control gas injection as taught by Bates et al. because it allows for faster control of gas.

Claim 25 is rejected under 35 U.S.C. 103(a) as being unpatentable over Otsubo et al. in view of Mahawili as applied to claims 19, 20, 21, 23, 24, 26 and 27 above, and further in view of Eres et al. (U.S. Pat. 5,164,040).

The difference not yet discussed is the use of supersonic gas injection.

Eres teach injecting into the chamber a gaseous source of material in the form of **a pulsed supersonic jet** so as to obtain a high incidence rate. **The supersonic jet is produced by a pulsed valve** between a relatively high pressure reservoir, containing the source gaseous molecules, and the deposition chamber. (See Abstract)

By alternately pulsing two nozzles, epitaxial structures can be formed in which successive layers have different compositions. (Column 4 lines 5-10)

The motivation for utilizing supersonic gas flow is that it allows for having a high incidence rate. (See abstract)

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have utilized a supersonic gas injection nozzle as taught by Eres et al. because it allows for having a high incidence rate.

#### ***Allowable Subject Matter***

Claims 7-18 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Claims 7-18 are indicated as being allowable over the prior art of record because the prior art of record does not teach the claimed subject matter of claim 1 in combination with introducing a first process gas into the reactor chamber during a first time period and introducing a second process gas having a different composition than the first process gas during a second time period which follows the first time period.

***Response to Arguments***

Applicant's arguments with respect to claims 1-6 and 19-27 have been considered but are moot in view of the new ground(s) of rejection.

Applicant's have argued that Winniczek et al. does not teach maintaining the plasma with their RF source. The Examiner agrees that Winniczek does not teach maintaining the plasma with the RF source since it is utilizing an RF bias to the substrate. However, newly cited Otsubo et al. teach providing only a single RF source for generating the plasma and it utilizes two different energy levels to achieve etching (i.e.  $V_2$  and  $V_3$ ). The plasma is not stopped and is maintained because it continuous switch between the two values. (See Otsubo et al. discussed above)

This action will be made NON-Final based on the newly cited reference.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Rodney G. McDonald whose telephone number is 571-272-1340. The examiner can normally be reached on M- Th with Every other Friday off.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nam X. Nguyen can be reached on 571-272-1342. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



Rodney G. McDonald  
Primary Examiner  
Art Unit 1753

RM  
August 5, 2004